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(54) **Rotor for the treatment of molten metal**

Rotor zur Behandlung von geschmolzenem Metall

Rotor pour le traitement de métal fondu

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Description

[0001] The present invention concerns a rotor for the treatment of molten metal by the addition of gas and/or particulate material, which rotor comprises a hollow rotation body with openings in the base and side which is mounted on a shaft and driven via the shaft by a drive unit and which is designed to be lifted out of and lowered into the liquid.

[0002] Equipment and methods have previously been known for treating a liquid and adding particulate material to it as stated above. The applicant's own Norwegian patent no. 155.447 describes a rotor for treating a liquid and adding material to it in which the rotor comprises a rotationally symmetrical hollow body and in which the material is added to the liquid via a hole drilled in the rotor shaft and emerges through holes in the side of the hollow body together with the liquid, which is sucked in, by means of centripetal force, through an opening in the base and circulated through the body.

[0003] This rotor produces a high liquid treatment capacity, i.e. the admixture of gas or particles, with very little agitation or turbulence in the liquid.

[0004] A general requirement for rotors for liquid treatment, in particular treatment of molten metals, is that the admixture of gas or particulate material is efficient. However, it is also desirable to avoid the creation of a great deal of agitation or turbulence which leads to an agitated surface and vortices in the liquid and which thus leads to increased admixture of gas from the surroundings (atmosphere).

[0005] According to an aspect of the invention there is provided a rotor as claimed in claim 1.

[0006] The present invention represents a solution with rotors for liquid treatment in which the efficiency of the admixture of the gas or particles to a liquid is almost doubled, but in which the agitation is unchanged compared to the solution shown in the applicant's own Norwegian patent. Moreover, the present invention represents a solution with rotors in which the gas/particle requirement (consumption) is more than halved. The present invention is characterised in that the hollow rotation body is provided, in its cavity, with at least one partition wall so that one or more annular chambers are formed and that gas and/or liquid is/are supplied to the or each annular chamber and the central cavity via channels and/or holes in the respective partition wall(s) or body(ies).

[0007] The dependent claims 2-3 define preferred embodiments of the present invention.

[0008] The present invention will be described in the following in further detail using examples and with reference to the attached drawings, where

Fig. 1 shows a known rotor, as described in the applicant's own Norwegian patent no. 155.447, seen a) in cross-section and b) from above.

Fig. 2 shows a rotor in accordance with the present invention seen a) in cross-section, b) from above and c) from the side.

5 Fig. 3 shows an alternative embodiment of the rotor shown in Fig. 1 in accordance with the present invention seen a) in cross-section, b) from above and c) from the side.

10 Fig. 4 shows another alternative embodiment in which, instead of partition walls, an internal rotor is used.

15 Fig. 5 shows another embodiment of a rotor in accordance with the present invention with several partition walls seen in cross-section.

Fig. 6 shows diagrams of results from comparative tests at three different RPM values.

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[0009] As stated above, Fig. 1 shows a known rotor as described in the applicant's own Norwegian patent no. 155.447. The rotor consists of a hollow, rotationally symmetrical body which has a smooth surface both externally and internally and which is provided with openings 5, 9 in the base and sides. The body 1 is connected to a shaft 2 which, in turn, is driven by a drive unit (not shown). Gas and/or particulate material is/are supplied to the rotor through a drilled hole 3 and, when the rotor is in operation, i.e. when the rotor is rotating, the gas, and the liquid which is sucked into the rotor through the hole 5 in the base, will be pressed out through the openings 9 in the side and will be finely distributed in the liquid.

25 **[0010]** Fig. 2 shows a first example of a rotor in accordance with the present invention. It comprises a rotationally symmetrical body 1, preferably cylindrical, which has a smooth surface externally and internally and which is connected to a shaft 2 with a coaxial drilled hole 3 for the supply of gas and/or particulate material. The shaft 2 is connected to and driven by a drive unit (not shown).

30 **[0011]** The special aspect of the present invention is that the rotation body 1 is provided with an internal, rotationally symmetrical partition wall 4 which extends just below the opening 5 in the body 1 and which, at its upper end, extends outwards in a funnel-shaped part 6 and is fastened to the body 1 internally. The partition wall 4 thus defines an internal, centric cavity 7 and an annulus 8. In the example shown here, the body 1 is provided with four upper holes 9 which correspond to the centric cavity 7 and four lower holes 10 which correspond to the annulus 8. Moreover, the partition wall 4 is provided with four holes 11 which form a link between the centric cavity 7 and the annulus 8. The holes 9, 10, 11 can be arranged along the same vertical line or can be offset along the circumference of the rotor.

35 **[0012]** The rotor in accordance with the present inven-

tion functions as follows: the rotor is lowered into a liquid, for example molten metal, and is caused to rotate. The liquid will now, on account of the rotation of the rotor and the consequent centripetal force produced in the liquid, be sucked up, partially through the annulus opening 5 formed between the partition wall 4 and the wall of the body 1, partially through the opening 12 for the centric cavity 7 formed by the partition wall 4, and will be pumped out through the holes 11 and 10. Gas and/or particles which is/are supplied through the drilled hole 3 in the rotor shaft will, at the same time, partially be pressed through the upper holes 9 and partially through the lower holes 11 in the rotor wall and the partition wall 4. The gas which flows through the holes 9 will immediately be broken down into small gas particle fractions on the outside of the hole on account of the friction against the liquid on the outside of the rotor. The gas, together with the liquid which flows out through the holes 11, will be partially broken down and flow up towards the lower holes 10 in the rotor wall 1 and will be further broken down into small gas particle fractions immediately on the outside of the holes 10 in the same way as the gas which flows through the holes 9.

[0013] Fig. 3 shows an alternative embodiment of the solution shown in Fig. 2. The rotation body 1, the partition wall 4 and the upper and lower holes 9 and 10 are the same. The difference is that the holes 11 in the partition wall 4 have been removed. Instead, gas is supplied to the annulus 8 via drilled holes 13 in the wall 14 in the rotor 1 and shaft 2. Gas is supplied to the centric chamber 7 through the centric drilled hole 3 in the shaft 2 in the same way as in the example shown in Fig. 2.

[0014] In this example, the liquid will be sucked up into the centric chamber and flow out through the upper holes 9 together with the gas supplied through the drilled hole 3, and the liquid which is sucked up into the annulus 8 will flow out through the lower holes 10 together with the gas supplied through the drilled holes 13 in the shaft 2 and the rotor wall 14. The principle and method of operation are otherwise the same as in the example above. This solution shown in Fig. 3 is somewhat more expensive to produce than the solution shown in Fig. 2 as a result of the drilled holes 13 in the rotor wall/shaft. However, the efficiency in connection with the admixture of gas is somewhat higher.

[0015] The present invention, as it is defined in the claims, is not limited to the examples shown in the drawings and described above. For example, instead of partition walls which are permanently connected to the rotation body 1, a second rotationally symmetrical body 16 can be arranged inside the cavity in the rotation body 1 by means of a coupling piece 15 or another method, as shown in Fig. 4. The wall of the second rotation body 16 thus forms a partition wall 4. It is expedient for the second rotor not to be screwed completely in so that an opening 17 between the rotors is formed. This allows the gas for the outer chamber 8 to be supplied via the shaft drilled hole 3 and through the gap 17 between the

two rotors.

[0016] Moreover, the present invention is not limited to one partition wall. It may have two or more partition walls or internal rotors. Fig. 5 shows an example of a rotor 1 in which three partition walls 4 are used to divide the internal cavity in the rotor into a centric chamber 7 and three annuli 8 to which gas can expediently be supplied in the same way as shown in Fig. 2 or 3 (not shown in further detail).

[0017] With several partition walls, the efficiency can be further improved in comparison with the solutions shown in Figs. 2 and 3 and the consumption of gas/particles will be further reduced.

15 Tests:

[0018] Comparative tests were performed with a known rotor as shown in Fig. 1 and a new rotor in accordance with the present invention as shown in Fig. 3. The tests were based on the removal of oxygen from water using nitrogen gas.

[0019] The rotors were tested in a container in a water model with water flow of 63 l/min. The rotors which were tested were in the scale 1:2 in relation to standard size. The external dimensions were the same and the holes in the base and side had the same diameter.

[0020] The rotors were driven by a motor of 0.55 kW at 910 RPM at 50 Hz. The RPM were regulated using a 3 kW regulator of type Siemens Micromaster with a variation range of 0-650 Hz.

[0021] Nitrogen gas from a 200-bar, 50-litre nitrogen bottle was used and the gas was supplied through the drilled hole in the rotor shaft via a reduction valve and rotameters of type Ficher and Porter. The oxygen in the water was measured with an oxygen meter of type YSI model 58 (digital meter).

[0022] Furthermore, a water meter of type 5px (Spanner-Pollux GmbH) with a capacity of 2.5 m³/h was used to measure the water quantity.

[0023] Moreover, a digital tachometer of type SHIMPO DT - 205 was used to determine the RPM.

[0024] The two rotors were tested in the same container under the same conditions with a water flow of 63 l/min. After adjusting the water quantity, each rotor was started and the RPM were regulated to the desired speed. The oxygen measurement and timekeeping were started as the supply of nitrogen gas was switched on. Three different RPM values were used during the tests, 630, 945 and 1071 RPM, which, for rotors in the scale 1:1, would be equivalent to 500, 750 and 85 RPM respectively. Moreover, five different gas quantities were used during the tests: 12, 6; 25, 2; 37, 8; 50, 4 and 63 lN/min.

[0025] For the rotor in accordance with the present invention as shown in Fig. 3, the gas was introduced in four different ways:

- Gas only in the upper row of holes

- Gas only in the lower row of holes
- Equal gas quantities in both rows of holes, a total of: 12, 6; 25, 2; 37, 8; 50, 4; 63 IN/min.
- Double gas quantities, i.e. in each row of holes: 12, 6; 25, 2; 37, 8; 50, 4 and 63 IN/min.

[0026] The results of the tests are shown in Fig. 6, which shows three diagrams, one for each RPM value. The known rotor as shown in Fig. 1, which, in the diagrams, is designated the "standard rotor", was, until the present invention was conceived, considered to be the best on the market in terms of efficiency together with low turbulence and agitation.

[0027] In the tests, it was possible to see that the agitation and turbulence in the liquid (water) were just as low with the new rotor in accordance with the present invention. The diagrams show, however, that the efficiency of the new rotor, measured as oxygen removed from the water, is nearly twice that of the known rotor at low quantities of nitrogen gas supplied and is improved by approximately 50% at the highest quantity of nitrogen gas supplied. The diagrams also show that it does not matter greatly where the nitrogen gas is supplied in the rotor, i.e. whether it is supplied to the upper or lower row of holes or to both rows of holes simultaneously. This is on account of the good bubble distribution achieved with the new rotor and the fact that part of the gas is pressed back into the rotor before being distributed out through both rows of holes.

Claims

1. A rotor for the treatment of molten metal by the addition of gas and/or particulate material comprising a hollow rotation body (1) having an open base (5) and openings (9,10) in its sidewall, the body (1) being mounted on a shaft (2), which extends from the top of the body (1) and is driven by a drive unit, the shaft (2) having an opening (3) to supply gas and/or particulate material to the hollow interior of the body (1), the rotor being arranged for submersing in and lifting out of molten metal and being **characterized in that:**

at least one cylindrical partition wall (4) is provided in the hollow interior of the body (1), creating at least one annular chamber (8) and a central cavity (7), each having an open base and communicating with openings in the sidewall of the hollow body (1), and gas and/or particulate material is supplied, in use, to the central cavity (7) via the opening (3) in the shaft (2) and to the or each annular chamber (8) via openings (11,17) in the or each partition wall (4) and/or additional channels (13).

2. A rotor according to Claim 1 wherein the or each

partition wall (4) includes openings (11,17) such that parts of the gas and/or particulate material supplied to the central cavity (7) are supplied to the or each annular chamber (8) via the openings (11,17) in the or each partition wall.

3. A rotor according to Claim 1 or Claim 2 wherein the shaft (2) further includes additional channels (13) to supply gas and/or particulate material to the or each annular chamber (8).

Patentansprüche

1. Rotor für die Behandlung von Metallschmelze durch den Zusatz von Gas und/oder Teilchenmaterial, umfassend einen hohlen Drehkörper (1) mit einer offenen Basis (5) und Öffnungen (9,10) in seiner Seitenwand, wobei der Körper (1) auf einem Schaft (2) angebracht ist, der sich von der Oberseite des Körpers (1) erstreckt und durch eine Antriebseinheit angetrieben ist, wobei der Schaft (2) eine Öffnung (3) zum Zuführen von Gas und/oder Teilchenmaterial zu dem hohlen Innenraum des Körpers (1) aufweist und der Rotor zum Eintauchen in und Herausheben aus der Metallschmelze angeordnet ist und **dadurch gekennzeichnet ist, dass:**

mindestens eine zylindrische Trennwand (4) in dem hohlen Innenraum des Körpers (1) vorgesehen ist und mindestens eine ringförmige Kammer (8) und einen zentralen Hohlraum (7) bildet, die jeweils eine offene Basis aufweisen und mit Öffnungen in der Seitenwand des hohlen Körpers (1) kommunizieren, und Gas und/oder Teilchenmaterial im Einsatz dem zentralen Hohlraum (7) über die Öffnung (3) in dem Schaft (2) sowie der oder jeder ringförmigen Kammer (8) über Öffnungen (11,17) in der oder in jeder Trennwand (4) und/oder zusätzliche Kanäle (13) zugeführt wird.

2. Rotor nach Anspruch 1, wobei die oder jede Trennwand (4) Öffnungen (11,17) aufweist, so dass Teile des dem zentralen Hohlraum (7) zugeführten Gases und/oder Teilchenmaterials über die Öffnungen (11,17) in der oder in jeder Trennwand der oder jeder ringförmigen Kammer (8) zugeführt werden.
3. Rotor nach Anspruch 1 oder 2, wobei der Schaft (2) ferner zusätzliche Kanäle (13) zum Zuführen von Gas und/oder Teilchenmaterial zu der oder jeder ringförmigen Kammer (8) aufweist.

Revendications

1. Rotor pour le traitement de métal fondu par addition

de gaz et/ou de matière particulaire, comprenant un corps de rotation creux (1) présentant une base ouverte (5) et des ouvertures (9, 10) dans sa paroi latérale, le corps (1) étant monté sur un arbre (2) qui s'étend du haut du corps (1) et est entraîné par une unité d'entraînement, l'arbre (2) présentant une ouverture (3) pour fournir du gaz et/ou de la matière particulaire à l'intérieur creux du corps (1), le rotor étant disposé pour s'immerger dans du métal fondu et en sortir et étant **caractérisé en ce que** :

au moins une paroi de séparation cylindrique (4) est prévue dans l'intérieur creux du corps (1), créant au moins une chambre annulaire (8) et une cavité centrale (7) présentant chacune une base ouverte et communiquant avec des ouvertures dans la paroi latérale du corps creux (1), et du gaz et/ou de la matière particulaire sont fournis, en utilisation, à la cavité centrale (7) via l'ouverture (3) dans l'arbre (2) et à la ou chaque chambre annulaire (8) via les ouvertures (11, 17) dans la ou chaque paroi de séparation (4) et/ou les canaux supplémentaires (13).

2. Rotor selon la revendication 1 dans lequel la ou chaque paroi de séparation (4) comprend des ouvertures (11, 17) de sorte que des parties du gaz et/ou de la matière particulaire fournis à la cavité centrale (7) soient fournies à la ou chaque chambre annulaire (8) via les ouvertures (11, 17) dans la ou chaque paroi de séparation.
3. Rotor selon la revendication 1 ou 2 dans lequel l'arbre (2) comprend en outre des canaux supplémentaires (13) pour fournir du gaz et/ou de la matière particulaire à la ou chaque chambre annulaire (8).

Fig. 1

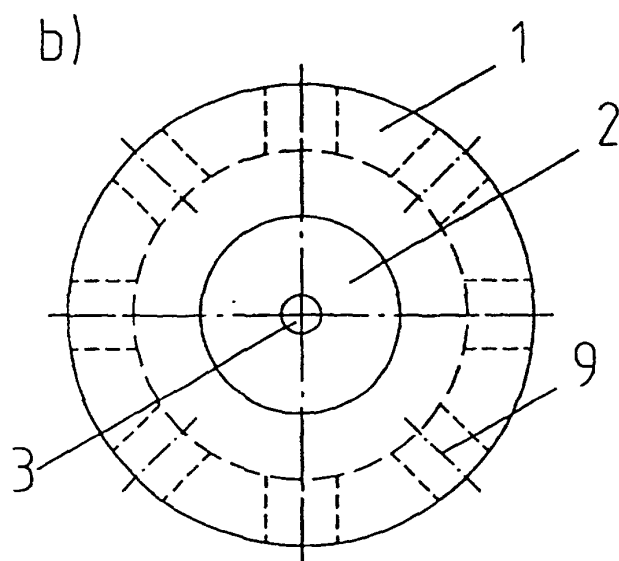
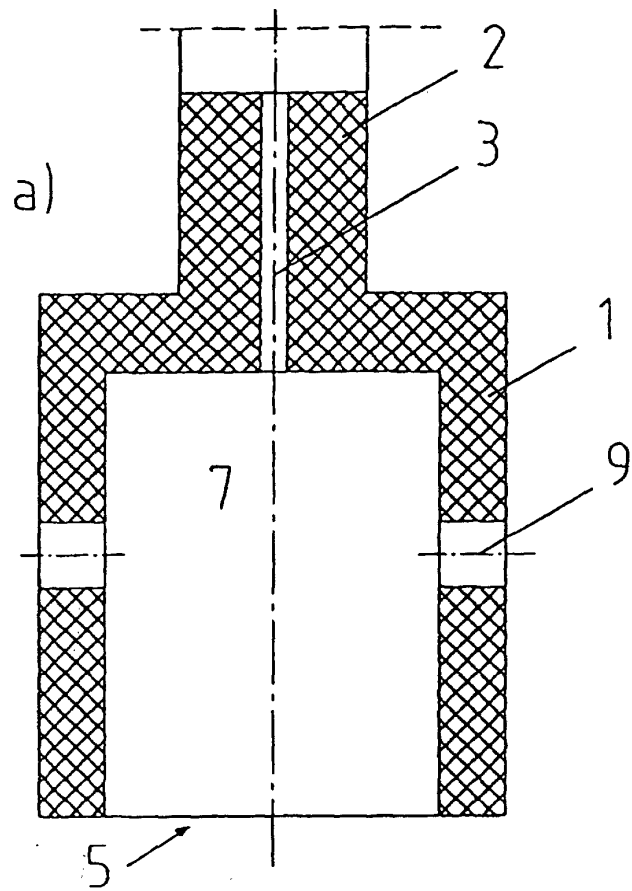


Fig. 2

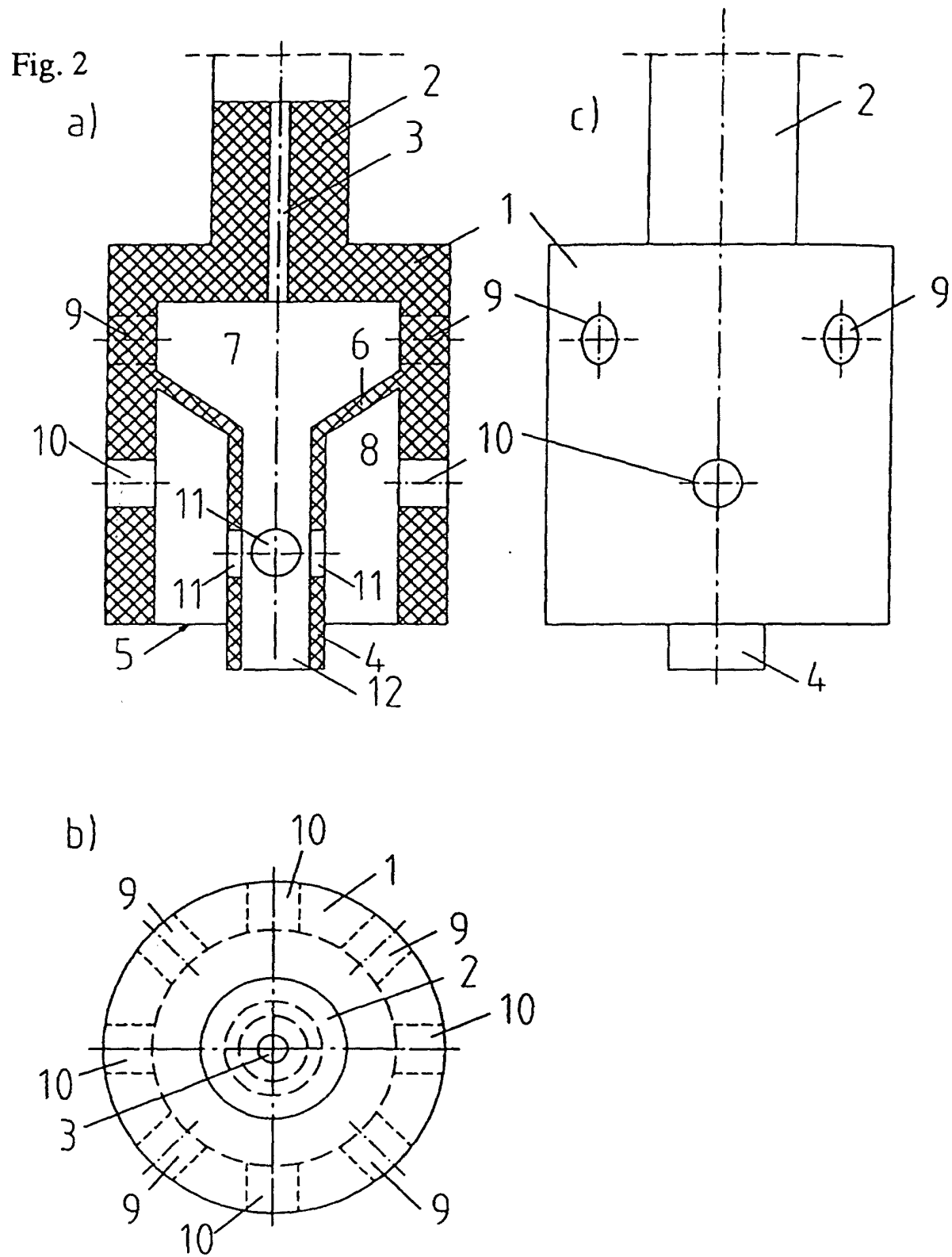


Fig. 3

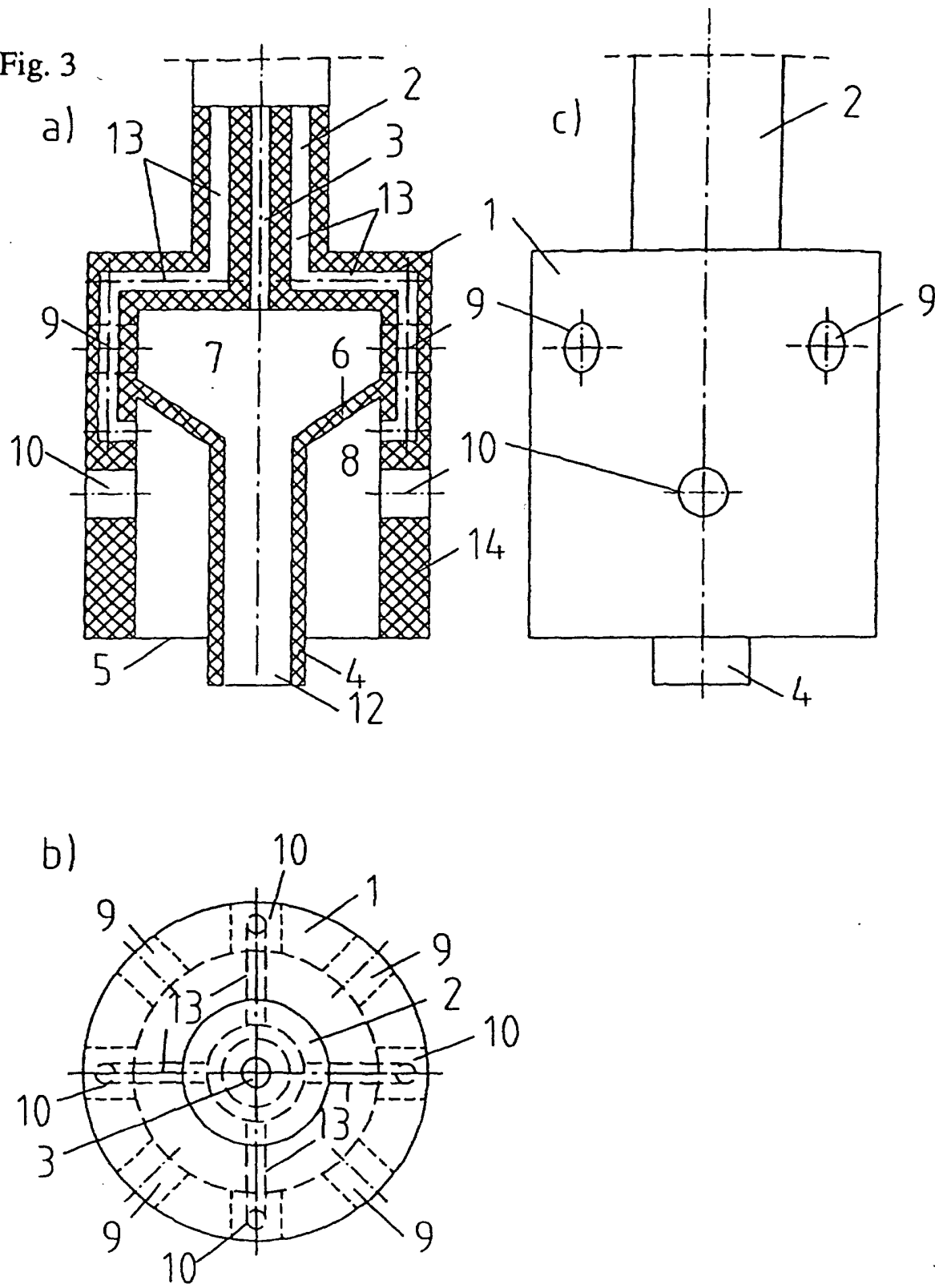


Fig. 4

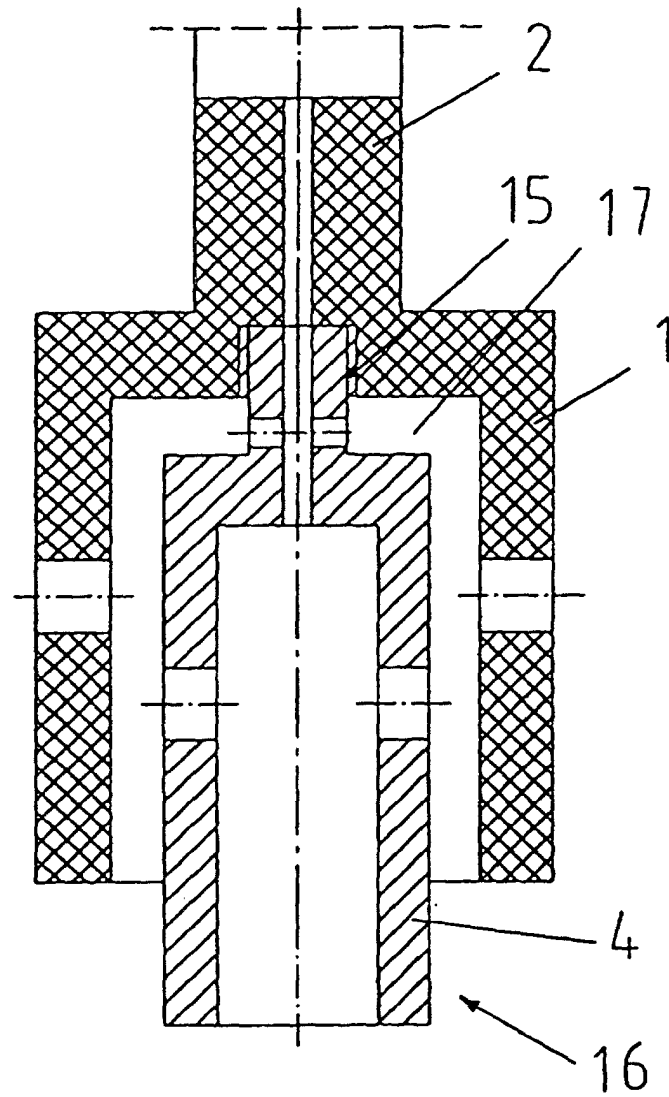


Fig. 5

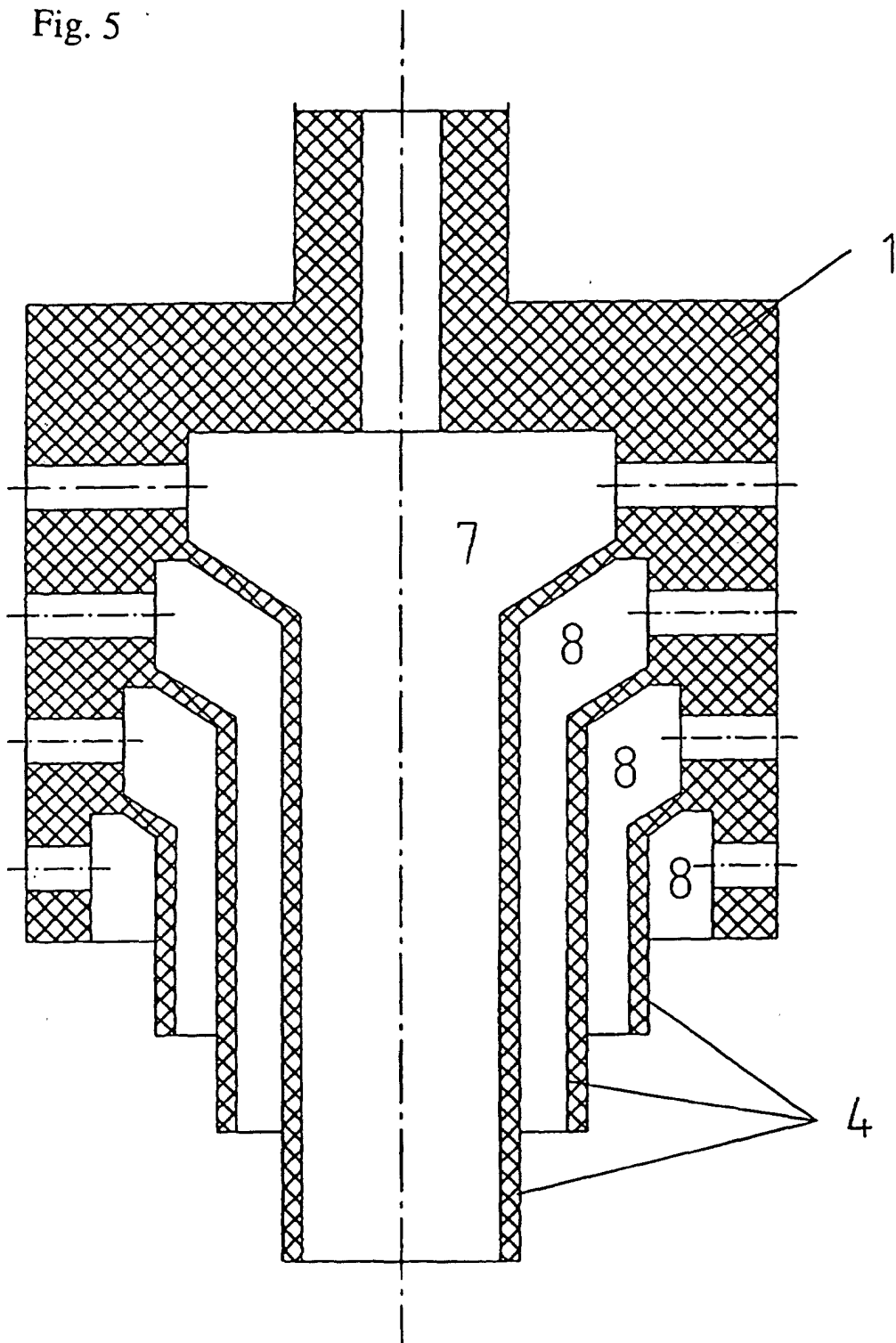


Fig. 6

